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The Final Report and White Paper are the same, except the Final Report has an added Appendix E – 2 publications.

Games are available for download:

<http://earthworksbuilder.github.com/>

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Meet the Earthworks Builders: a Flash-based video game

The computer is the new tool, the new medium that links the concept of information and art together. ... Due to the computer's complexity and its capability of being used for such diverse possibilities, it is a tool and a medium with its own built-in agenda. Electronic tools have a hidden point of view far more complex than that built into a brush, printing press, or a camera (Lovejoy, 1992, p. 139, 142, as cited in Rogers, 1995, p. 17).

Games are now the “new” tool. Even though video games have been around for over 40 years, employing them as viable learning environments is relatively new. In the last few years, a lot of people have begun researching games and learning: how to make them, use them, and assess what is happening when learners use them. There is a dearth of research about how games can teach and how what is learned can be translated (Becker, 2010; Ng, Plass, & Zeng, 2009; Wellings & Levine, 2009). There is not a preferred or proven method for determining how to assess how games teach specific learning objectives nor how well embedded assessment works within games.

With support from the National Endowment for the Humanities we began to address these questions and joined the conversation about best practices for educational game design. We utilized a consulting collaborative approach, created a Native American Advisory Board, made a prototype, 2D mini-game that focuses on the Newark Earthworks as a lunar observatory, and obtained additional funding to create an affinity space (Gee, 2012). This participatory, online community is in development. It is comprised of a website and an achievement system that ties together the myriad topics that can be understood by studying the earthworks and that will link to other online resources. We created a development blog so that stakeholders and interested outsiders could track our progress (<http://meet-the-earthworks-builders.posterous.com>). Furthermore, we attended several conferences at which we presented talks, demos, a poster, and we wrote a paper about our approach to making a game to teach empathy (in press). To fully develop the game, we applied to the National Science Foundation for a full-scale development grant in January 2013. Working on this project has been a journey for us. This journey has helped us to more deeply explore the complexity of representation of Native Americans, the Newark Earthworks and other such structures, and how to best allow the earthworks and related artifacts to reveal the forgotten knowledge that was known and practiced when they were built.

For example, after our fall 2011 meetings, the game design focused on the Newark Earthworks as a lunar observatory. This was in response to the Native American Advisory

team's charge to portray Native Americans as complex and sophisticated. During initial meetings, the following themes and design intentions were identified: gifting, ownership, displacement, and an intention to create in the player a sense of awe and curiosity, a desire to inquire, and an avenue to understand those who built the earthworks—to “meet” them personally and make a connection with them. As Bill Schmitt, science educator, said, the best way to get to know someone is have a conversation with him or her, as opposed to being told about him or her (personal communication, content team meeting, 2011). Our new tagline became: a game connecting Earth, the moon, and the past. Allen Turner, a professional game designer and Native American of the Lakota Nation, joined our team as we reworked the game design for the NSF grant. He explained that more than “meet” them, the player must identify with them through role-playing, and the new game treatment emerged that is described below (personal communication, November 2012). This brought us back to the original idea we had when writing this NEH grant, but that we had found was easier said than done. That being, we wanted to make a role-playing game.

Creating systems with games gives educators a way to structure an experience that expands a player's worldview. That is a primary desired outcome for the video game our team has been designing. Expanding a player's worldview translates in our case to the player understanding that ancient Native Americans were complex, sophisticated people; they were scientists, engineers, and mathematicians using the technology of their time to establish a relationship among themselves, the earth, and the sky. We have come to realize that our game is about teaching Indigenous Ways of Knowing Nature, essentially STEM topics from an Indigenous Science perspective. We prefer to rewrite STEM to include the A for art: STEAM.

Art embodies a creative approach to understanding the world. Artists, like scientists, continually push the boundaries, seek new ways of expressing the known and the unknown world, and use all sorts of materials. Art communicates cultural values and social meaning (Ballengee-Morris, 2012; Keifer-Boyd, Amburgy, and Knight, 2003). While many discussions about using video games for teaching and learning focus on how games support STEM areas, integrating socioemotional intelligence and art as part of the educational experience are also necessary (Gee & Hayes, 2010). They state, “there is no real divide between technology and art.” And, it is “the arts that drive us to see things in new ways leading to new solutions” (2010, p. 15). Fostering creativity is necessary because it is integral to problem solving (Robinson, 2006).

Research is essential to good design and to ensuring that the learning outcomes are achieved. Squire, (2011) suggests that the best research models are ones that are co-constructed with teachers and take into account that we live in a participatory culture. To this end, we aspire to co-construct with end-users and those who teach in formal and informal education venues. We desire to provide a game and an affinity space from which a Native American voice can emerge and provide teachings that are nuanced and accurate.

Consulting Collaborative Approach

The most important development from this project was the formation and expansion of the Native American Advisory Team. This has proven to be so empowering and affirming that

we believe it serves as a model for how other projects should involve Native Americans. We believe that Native American voices are essential to the design and implementation of the project. We are navigating processes to develop and design learning content in collaboration with those we seek to represent in media.

Background

When we began this project, our Native American advisory team consisted of the PI, Christine Ballengee-Morris, Marti Chaatsmith, associate director of the Newark Earthworks Center, and Chief Glenna Wallace of the Shawnee, Eastern Band. Originally, we intended that those who were Native American would simply contribute their ideas as part of the larger team. However, Chief Glenna Wallace, being a Chief, is the equivalent of a President. She is powerful. Collaborations among tribes may meet differences in protocols, hierarchies, and ways of communicating. We decided that it would be best for the Native Americans to meet over dinner prior to the Content. In that way sensitive issues could be freely discussed. Then, during the meeting with the content experts and game designers, the Native Americans could have one voice.

From that dinner meeting of Christine, Marti, and Chief Glenna, a way of reconciling the past with the present has emerged. They talked about what was most important to them and made a list that Marti shared with the group during our meeting the next day. The most important point was that the Earthworks Builders be portrayed as sophisticated and complex people. That intention drove all the game design decisions.

A few months into the project, we realized the implications of asking the Native Americans to meet independently from the other project participants, and that we were practicing a consulting collaborative approach. Building upon James Gee's (2012) concept of an affinity space, we submitted an idea for how to create an badge system and website to the 4th Digital Media and Learning Competition, held in conjunction with the Mozilla Foundation, supported by the MacArthur Foundation, and administered by the HASTAC Initiative (Humanities, Arts, Science, and Technology Advanced Collaboratory), hereafter referred to as DML grant. We were partnered with Digital Watershed, and together, we won an award. Digital Watershed is responsible for the creative and technical development of the content. For the next stage of the project, we expanded the Native American Advisory Team adding three more people: Sonay Atalay, Anthropologist; Chadwick Allen, English Professor and coordinator, American Indian Studies at OSU; and Ruth Voights, Art professor and board member of Digital Watershed. Because we had partners from outside the state, it was more important than before that the Native American Advisory Team determine the content and symbols to focus upon, explain particular words to use or not to use, and guide the understanding of Native American concepts and ways of knowing. This process worked so well that when we wrote the NSF grant, we expanded the team again and added two Native American scientists who will oversee the Indigenous Science aspects (please refer to the explanation of Indigenous Ways of Knowing Nature below), a Native American game designer, an art integration school teacher, and a museum educator from the American Indian Cultural Center and Museum in Oklahoma. The Native American Advisory Team will have a strong voice as the project continues to develop. They will

guide, direct, and give advice about how to develop the game and extra content as well as provide help with outreach and participate in the research.

Application of a Consulting Collaborative Approach

A Consulting Collaborative approach as understood by Lynda Tuhiwai Smith (2005) and the critical consciousness of Paulo Freire guide the process of this project. Art Education, now Art Administration, Education, and Policy, is primarily focused on visual culture and identity issues; thus, Action Research and a consulting collaborating approach were natural to our way of thinking and practicing. These approaches support building learning communities in the game as we develop the project among the researchers, consultants, Native American advisory team, youth advisory teams, and research subjects. Research subjects are also understood as contributing to the development, and their perspectives and ways of understanding are valued and will inform how the game is redesigned in the next iteration.

Our game design is an atypical bridge between the arts and sciences that embraces collaborative practices and creates coalitions. This is achieved by applying a consulting collaborative approach. By interviewing people and researching multiple viewpoints, we carry that method throughout the game design process with our multiple team approach: Native American Advisory, Content, Design, Research, and Core youth and young adult play-tester teams. Smith (2005) states that this process encourages reflective thinking and practice. “Consulting collaborative approaches include critical forms of reflective experiences, cultural studies, and research experiences that can challenge established ways of thinking and acting by encouraging a reexamination of one’s own values and practices” (Ballengee-Morris, 2010). This process builds learning communities, which support lifelong success and achievements through practices that question social problems, policies, and ethical dilemmas.

Defining Our Approach to Making Games – a short Literature Review

Any game, it could be argued, is an educational game; most game play requires the use of analytical and critical thinking, problem-solving, evidence based reasoning and because they are systems, they require the player to figure out that system, resulting in systems thinking. According to Salen (2008), “games, like other forms of media, are systems of meaning that are read, interpreted, and performed by players” (p. 10). Salen further explains that “the term system refers not just to the game itself, but to the entire tool-set available to the player within a gaming practice, including FAQs or strategy guides, cheats, forums, and other players in and out of multiplayer settings” (p. 13). Koster’s (2005) *Theory of Fun*, suggests “fun...is the feedback the brain gives us when we are absorbing patterns for learning purposes” (p. 96). He goes on to explain that the reason we like playing games is that they are safely unpredictable, allowing us to learn new patterns.

Games are engaging because it is fun to think and figure things out; when one wins or solves a puzzle it is rewarding and satisfying. Jane McGonigal (2010) asserts that games can affect people positively, influencing how they behave in the real world. She explains that acquiring things, earning more money, and receiving extrinsic rewards do little to

contribute to what really makes us happy or motivated to learn, which is similar to Daniel Pink and Alfie Kohn's ideas about intrinsic motivation. It is seeking something ourselves – intrinsic motivation – that leads to meaningful achievements and discoveries.

Achieving a state of “flow” keeps one engaged, learning, and immersed in a given activity. Csikszentmihalyi (1990) used the term “flow” to refer to the balance between challenge and ability to succeed. Chen (2007), a video game designer, summarizes Csikszentmihalyi's eight primary components of flow:

1. a challenging activity requiring skill;
2. a merging of action and awareness;
3. clear goals;
4. direct, immediate feedback;
5. concentration on the task at hand;
6. a sense of control;
7. a loss of self-consciousness; and
8. an altered sense of time. (p. 31-32)

This state of flow is what every good video game designer wants to provide. But, it is not easy. Anyone in education has likely experienced a state of flow, finding some topic so fascinating that all of the above occurs. Trying to impart that to learners is another story.

Enter educational games. While we know that games can achieve this, it is less known how a trail into an academic subject can be constructed within a game. The problem is that so much of school time is spent focusing on skill acquisition through memorization that the joy in learning is often absent. One study found that digital games could considerably improve students' knowledge of the subject matter as well as their enjoyment, engagement, and interest in learning. The findings were the same for both boys and girls (Papastergiou, 2009). Papastergiou's study supports other prior studies on the same topic (Klawe, 1999; Rosas, Nussbaum, Cumsille, Marianov, Correa et al., 2003; Ke & Grabowski, 2007) while also showing increased student academic achievement and motivation.

There is growing evidence that strongly suggests that non-traditional learners are more motivated when games are used in the classroom (Steinkuehler, 2010; Klopfer, Osterweil, & Hass, 2009) and that children with learning disabilities are better able to learn with games (Marino, 2011). Games seem to be finding their way into teaching environments, and for solid reasons. According to Van Eck (2006), “the core principle [of serious games is] that games can promote learning at higher taxonomic levels” (p. 22). Also, “games are good at involving students in a procedural experience” (Magerko, 2009, p. 1276). The 2011 Horizon Report projects that game-based learning will be widely adopted by higher education within two to three years. It states that “research and experience have already shown that games can be applied very effectively in many learning contexts, and that games can engage learners in ways other tools and approaches cannot” (Johnson, Smith, Willis, Levine, & Haywood, 2011, p. 22).

What games do best is contextualize learning and give the learner a non-linear path. If the player has to stop and answer questions, it interrupts her chosen path. Ideally, the player receives knowledge when it is needed (Gee, 2007). As in life, one does not seek information until it is needed for a purpose. Digital games may provide the impetus to embrace Dewey's conception of formal education: It is primarily a social institution. He believed that education should support both the psychological and sociological aspects of a child's development, building upon children's interests and abilities and connecting them to the community. He stated, "education ... is a process of living and not a preparation for future living" (p. 127). And, he wrote, "the teacher is not in the school to impose certain ideas or to form certain habits in the child, but is there as a member of the community to select the influences which shall affect the child and to assist them in properly responding to these influences" (2008, p. 129). Game-based learning advocates learners' use of games as a process leading to engagement in real-world activities, participating in communities of practice, and becoming producers (Jenkins, 2006; Gee & Hayes, 2010; Gee & Shaffer, 2010; Prensky, 2010; Shaffer, 2006; Squire, 2011).

Making the game – design intentions and iterations

During the game design meeting in December, when Dan Norton, game designer and consultant on the project, asked the game design team in Columbus what the game should be about, Michelle realized that the Newark Earthworks has a lunar observatory. Only sophisticated people could construct a lunar observatory. The game had to focus on that. Over the next few months, the game design team thought of several ideas that might demonstrate this. The game design team wanted to lead the player into discovering the observatory mound and witnessing the northern-most lunar standstill that last occurred in 2006; it occurs only every 18.6 years. Eventually, we decided on "Catch the Moon" as the focus because we wanted to create an incentive for players to replay the game. The game states diagram represents the actions that were to be programmed and essentially explains the game play (Appendix A) and reflects our thinking in the Spring of 2012.

We also wanted to encourage players to see that the Newark Earthworks connected the sky and the earth and was integrated with their culture. To that end, we wanted to lead the player to that spectacular event. That would be the culmination of the player experience, the win state. Throughout the game, the richness of the environment would build, adding in sounds, more enhanced visuals like brighter stars or flashes of stars that would include the lines showing where a Native American constellation was. These things were to occur as the player "caught the moon" on the rise. To focus the player on the rise, points are awarded for catching the moon closer to the horizon and fewer to none as the moon rises. We also added a tail to the moon so that the player could track the movement of the moon as it travels in a monthly cycle. This feature would help the player to predict the next rise point (see Figure 1).

In its current iteration, the game's goal is to provide understanding through a Native American lens. All aspects of the project will support learning about these ancient ruins by encouraging people to consider who these people were, who their descendants might be, as well as why the mounds were built and what people may have done there. The game is intended to spark the imagination and provide evidence that has been gathered over the

years so that players will explore the earthworks in a holistic way, drawing upon multiple disciplines.

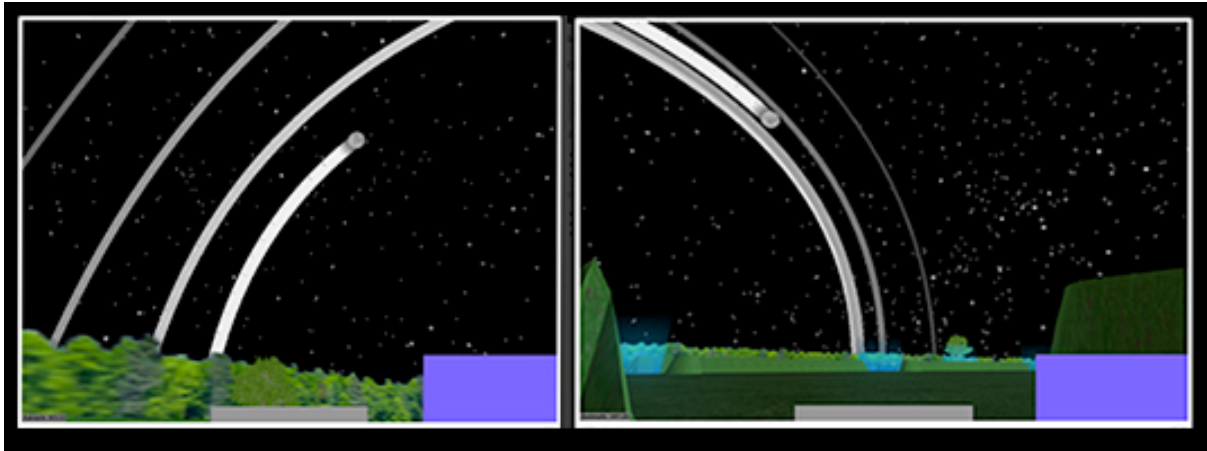


Figure 1. Putting a tail on the moon helps the player predict the next rise point.

How this Game embraces STEAM

The Newark Earthworks embody myriad concepts about Native American culture, both past and present, and one can refer to multiple academic disciplines for understanding. Dr. Ballengee-Morris chose this site as the focus for our game because she has a connection to it through her work with the Friends of the Mounds. In 2006, there was a movement to celebrate and experience the lunar standstill. The group formed as a result of confrontations with the Country Club. Their golf course spans the Octagon Mound; they limit access to the land and hold a lease on what was formerly a public park.

The Newark Earthworks has been nominated as a world heritage site. The Octagon Mound, which is a part of the larger Newark Earthworks, is a lunar observatory and one of many earthworks structures found in the US. It is also a cemetery, a public gathering place, a ceremonial center, a pilgrimage site, and more. Built by Native Americans' ancestors, earthworks, in general, provide a focus for exploring and understanding aspects of geophysics, astronomy, archeology, anthropology, cartography, geography, geology, historical architecture, history, art history, art, math, and Native American perspectives on science and culture — bringing the past into the present and supplanting stereotypes with the view that Native Americans are still here; they are scientists, engineers, mathematicians, and they were and still are sophisticated and complex peoples. As is typical in games, players will use evidence-based reasoning, problem solving, critical and analytical thinking, and systems thinking. Learners will also come to understand that perspectives and interpretation of evidence varies even among scientists. One's conclusions rely upon interpretation of data and prior understanding that shapes how one uses or applies new knowledge, which determines how one frames the next question. The game will encourage the learner to explore, consider, experiment, and ask questions. We will incorporate an Indigenous Science approach, which can be understood as a worldview reflecting a unique story, connected to the local environment (Maryboy, 2012).

Building on the successes of this NEH grant— Project Expansion, Outreach, and Influence

To fully develop this game, we have submitted a proposal to the NSF. We began working with Allen Turner, mentioned above, and with his help, have refined our ideas and incorporated the learning objectives into a new game treatment. We explained it as a digital game-based learning approach to science education that contextualizes STEM topics within a 2000+ year-old environment. It was a natural extension of the game we had been developing. The “catch the moon” game will become a 2D mini-game within the larger game context.

Defining Indigenous Ways of Knowing Nature (IWKN)

The game will endeavor to bridge two complementary ways of knowing: Western European Scientific approaches and Indigenous Science or “Indigenous ways of living in nature” (IWLN) (Aikenhead, 2011), which includes “diverse knowledge systems of Indigenous peoples worldwide” (p. 63) and is not limited to conservation and environmental topics. Aikenhead explains this distinction as necessary because “the noun ‘knowledge’ does not translate into most Indigenous languages, in part because English is a noun-rich linguistic system while Indigenous languages are verb-rich” (p. 65). IWLN assumes Indigenous meanings for “nature,” in which “nature is not simply a collection of objects [and energy], but rather a dynamic, ever-flowing river of creation inseparable from our own perceptions. Nature is the creative center from which we and everything else have come and to which we always return,” (Cajete, 2006, p. 205, as cited in Aikenhead, 2011). “Science learning ... must aim to facilitate the learning of the culture of science without also facilitating the assimilation of students into that culture” (Brayboy, 2008, p. 21).

Because games are primarily about “verbs”—what the player can do (reflected in game mechanics)—it is expected that IWLN can readily translate to a game environment. This game will focus on science as cooperative and collaborative, which may reach players who do not thrive in the often competitive European Scientific culture. That is not to say competition is negative, because it often allows for critical examination of new ideas (Aikenhead, 2011). Rather, the expectation here is that, with the threat of competition removed, those not readily drawn to ES as it is typically presented in schools will discover scientific inquiry and become intrigued with the myriad ways science can be employed in coming to know the past as it is understood through the ancient earthworks. It is not the intention to portray IWLN or the game topics as pan-Indian. Simply in defining IWKN one is challenged because “different tribal nations and individuals within those communities have different understandings of this topic” (Brayboy & Castagno, 2008, p. 13). A challenge to be sure, and that is why we formed a Native American Advisory team and will employ a consulting collaborative approach, researching multiple points of view.

Game Overview

We want players to question why the earthworks were built and what people may have done there. “Earthworks Builders” (working title) will invite players to explore an ancient earthwork through the eyes of a Native American villager learning to guide his/her people. The Earthworks is not only a tool to track the moon, but is a place to learn forgotten knowledge; everything seen is more than it first appears.

The game is a journey that begins with the player as a child who walks through the space with an elder. From a first-person perspective the learner is presented with tasks and quests to undertake—modeled more closely to experiences like World of Warcraft or Skyrim (Simpkins, Dikkers, Owen, 2012) than typical fact-based edutainment delivery.

The game progresses as the player completes the narrative quests and serves the village. The observatory may also signify other events such as pilgrimages or festivals. Initial quests in the game will introduce key game mechanics and goals. Players will need to navigate and move, ‘listen’, and use a ‘see’ function that helps them to identify known items in the world. Players will also be introduced to surrounding ‘zones’ such as forest, water bodies, and prairies – each with unique plants, animals, rocks and minerals that have unique usefulness to the people of the village. The player is introduced to concepts that persist through the game: conservation of resources and attentive use of the earthworks helps re-spawn rates and maintain ecological balance, ‘perception’ increases as players gain experience serving the village.

Players will help to build the earthworks and be challenged by the math and technique of building it. The player will learn the knowledge of crafting and how to combine items. Items of ‘Use’ and items of ‘Beauty’ are found by exploring, gathering, and random events. Clues to locations for each can be sought by waiting in key locations to listen and wait to hear the stories from “moon,” “wind,” or “coyote.”

Progression in the story is not the only option for the player. The virtual space is also a sandbox-like world in which the player can explore, finding items and events that populate the world but are only visible based on their level of perception. Gathering items is done based on the need of the village or because an item is uniquely beautiful or sacred. “Taking” an item is one of three ways to “have” it; players can also capture visual and audio ‘memories’ that are recorded and added to collections. These compose a variety of sets. There will be mini games that can be played to ‘gather’ animals, minerals, flint, fish, or ‘catch the moon’ – these too can be replayed to gain expert scores that are part of an achievement system.

Learning Objectives

Players experience something from another perspective and have empathy for NAs. Players recognize that even within a specific scientific discipline, scientists may not all agree or have the same perspective. By communicating Indigenous Science as a way of knowing, or IWKN, the player will be intrigued and encouraged to learn more. Science concepts will be translated as game mechanics. Those who might think they cannot understand science are expected to realize that they can.

General Learning outcomes

1. *Understand science is a process* that can be practiced in interdisciplinary ways and is both subjective and objective. (Being able to evaluate information is critical for processing information. Within the game, we will look for ways to experience science as a interdisciplinary process requiring evaluation skills);

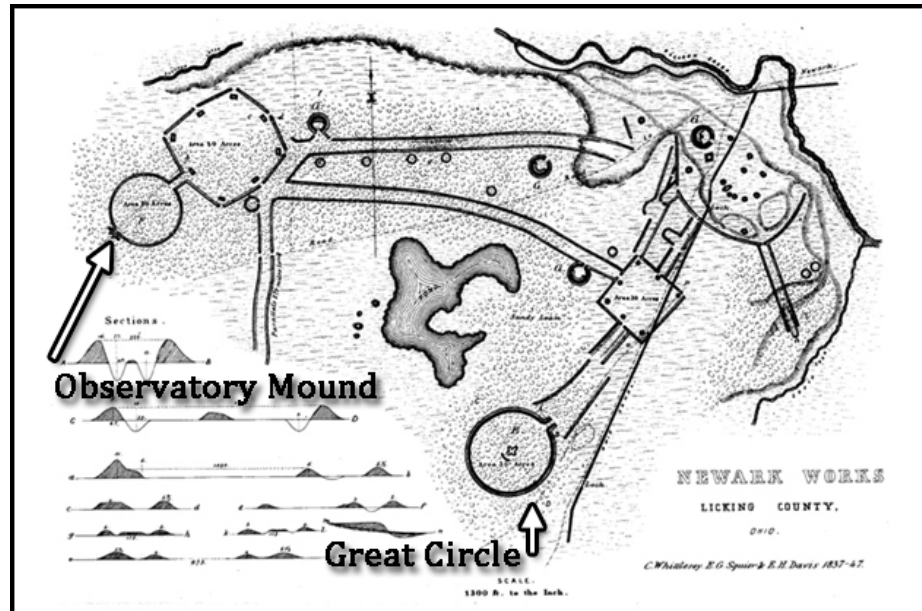
2. *Multiple perspectives.* The game will impact players' understanding of Native American scientific knowledge, players' adoption of native perspectives on scientific knowledge, and the emergence of player empathy/understanding of different cultural perspectives about scientific knowledge;
3. *Indigenous and nonindigenous learners will perceive the world through IWKN;*
4. *Encourage reflection,* seeing relationships and patterns relating to the earthworks;
5. *Encourage the generation of new knowledge by:*
 - a. uncovering the past by relating it to modern Native American practices and understandings.
 - b. encouraging Native American young people to enter science fields and find ways to understand the earthworks (indicators will be sought, but this research will not be longitudinal).

Primary Learning Objectives – playing the game will change one's relationship to the world (please reference the map of the Newark Earthworks below)

1. "Look up" and notice the stars and moon in one's neighborhood; After playing this game we expect that players will begin to notice the position of the moon and have a deeper appreciate for the complexity of how it moves; we want them to be curious about what significance this had for NAs;
2. Discover that the Earthworks Octagon precisely tracks the northernmost moonrise; Building something that is seemingly focused on an event that occurs only every 18.6 years is striking! Plus, it's just one section of the Earthworks? What were they doing every 18.6 years that would lead them to construct such an enormous structure? Some believe there was a road connecting Newark Earthworks with earthworks in Ross County, referred to as the Hopewell Road, perhaps part of a pilgrimage or ritual, and a feature we may incorporate into the game.
3. Understand the scale of the Newark Earthworks (~3,000 acres) and the builders used a unique measurement system, for example, the great circle is ~1,054 ft. in diameter and this measure is found in other places.
4. Players will gain a sense of resource management by experiencing the necessity of maintaining balance by not over-harvesting;
5. Players will learn geometric, engineering, and design principles. Building of the Earthworks required understanding engineering design for materials use, stability, and durability.
6. Transfer in-game crafting instructions to real life crafting and pursue the option for learners to communicate with artists practicing in traditional and non-traditional ways.

This project seeks to build IWKN both broadly and with a particular focus; and we believe this can set the stage for many more such efforts. We believe that connecting real-world experiences with online experiences (through a game) is necessary in order to translate skills learned to other topics that may result in DIY projects. Such DIY projects will be available on the Earthworks Badges website.

Newark Earthworks



Earthworks Badge System and website

Gee (2012) explains that “little g” is the game, and “Big G” is the learning community or affinity space that typically grows spontaneously in response to commercial games such as Civilization. The educational materials that do not readily translate into a game will comprise the “Big G” in the form of suggested activities, simulations, short interactives, links, and resources and possibly a wiki and forum. Shirkey (2011) suggests that a sense of ownership within an online community can blossom into a self-regulating, participatory community. Our intention is that by providing a context for a Native American voice to emerge, ownership of the online community will follow (see Figure 2).



With a few lines of code, this dynamic badge can be embedded anywhere.

The badge has four sections and within each section there will be options that lead to earning “strands.” Earning multiple strands from each section will indicate a level of mastery. The primary way learners will earn badge strands is by demonstrating learning through a creative response such as artwork, formal writing or a journal, video, podcasting, doing and documenting a hands-on project, and even making a game or website. Unlike many badge systems, the EBS is interactive and allows for learner customization. Each learner’s badge showcases the strands earned and links to the learner’s work on a personal blog. Awarding badge strands will be crowdsourced among the mentor community. Learners become producers and transition into mentor roles as they gain material mastery.



Figure 2. Conceptual designs for future web pages – home page, left and finding activities, right.

Development: Process, Technical Issues, Pitfalls, & Lessons Learned

As described above, the focus for the prototype was the Earthworks as a lunar observatory. That meant that the game environment would be composed of only the octagon and circle that form a lunar observatory, as opposed to the entire earthworks. John Hancock, Content Team and Professor of Architectural History at University of Cincinnati, co-founder of [CERHAS](http://cerhas.uc.edu/), Center for Electronic Reconstruction of Historic Archaeological Sites (<http://cerhas.uc.edu/>) and project director for [The Ancient Ohio Trail](http://www.ancientohiotrail.org/) (<http://www.ancientohiotrail.org/>), gave us accurate 3D models. Having these 3D models saved us an enormous amount of time. John attended our fall 2011 planning meeting and provided information that informed our development. Using Maya 3D software, we isolated the section that would be the game environment (see Figure 3). We used our own images to reimagine how the environment may have looked and also to differentiate this project from John's projects (see Figure 4). This we considered as placeholder art. Our goal is to hire a Native American concept artist(s) for the final game. We also anticipate hiring Native American musicians as needed.

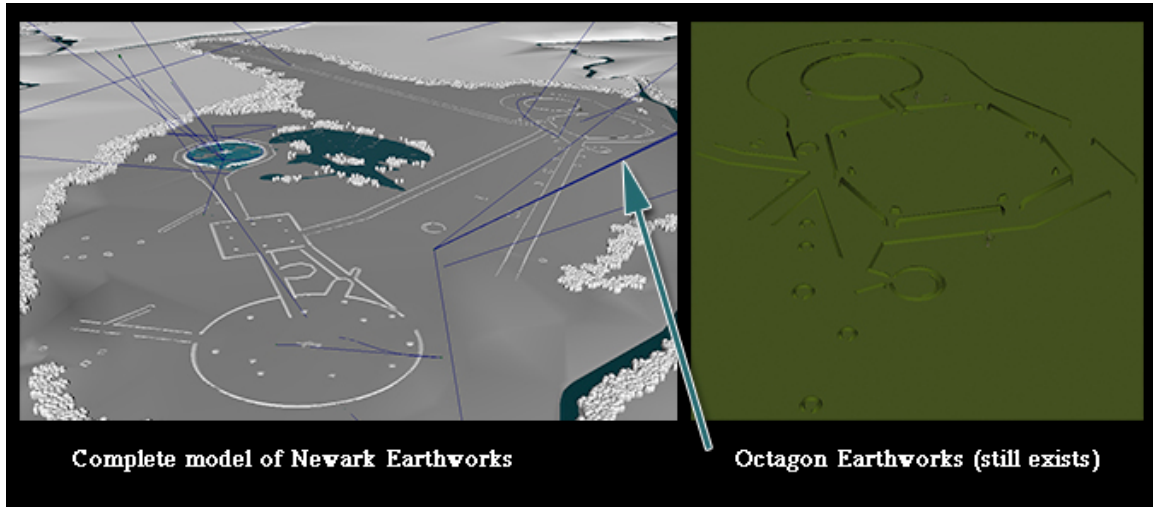


Figure 3. Model from CERHAS, left and isolated section used for the prototype game environment.

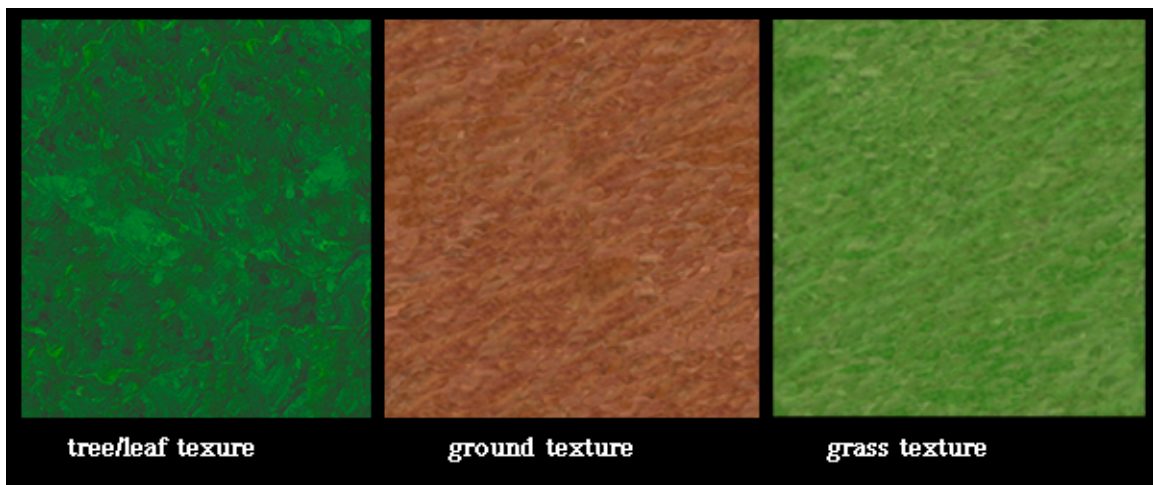


Figure 4. Tileable textures designed for 3D environment.

Game Design Team

The Game Design Team had three people: Michelle Aubrecht, environment art and sound; Tyler Ayres, interface design and assets; and Peter Gerstmann, developer. We asked Tyler Ayres to join us as the Art Director once the project was funded. Tyler is a Maya Expert, skilled designer, and Assistant Professor at Ohio University. In the fall of 2011, we met with Dan Norton, Game Designer and co-founder of Filament Games, an educational game company in Madison, WI. Dan shared design templates to help us organize our process. He also met with us on Skype to answer questions and give advice.

We set out to offer the player three ways to interact with the environment: control time, and one's position, and location. In the later iterations, the time slider was removed. It is represented in vo.8.0 and earlier versions as a gray bar along the bottom. Clicking to the left makes the stars go backward, to the right forward, and the center position makes time stand still. (Website with all of the releases: <http://earthworksbuilder.github.com/>).

We used Adobe Flash because it is widely used and therefore would be easily accessible from most computers. While the game has a 3D look, it is in fact an assemblage of images, on boxes and the player is inside the “box”. Images were taken in Maya and exported. Tyler engineered a system whereby a Maya camera would take six shots from 22 points (Figure 5). These images were fitted to the “boxes” Peter created, making one feel like one was in a 3D space. The player could look in any direction. To move, one simply clicks on another hot spot. When we participated in a game demo at Games + Learning + Society in June 2012, we found that people were confused by the green glowing spots and thought they must be on another planet (see Figure 6). Michelle made a rough-cut, introductory video (<http://www.youtube.com/watch?v=eWDUMpv3HTM&feature=youtu.be>) to contextualize the game environment as a place in Ohio, however, the problem of looking otherworldly persisted. An alternative solution was not sought because we ran out of time and funding.

For the next iteration of this game, we will use [Unity](#), a 3D game engine. Using it will solve some of our problems of artifacting and user navigation confusion (see below). Additionally, the professional version allows for output to Flash and tablets. When the grant proposal was written, this was not the case. Using Unity, we will be able to import the 3D model from Maya and navigating within the world is pre-built. Much of the work Peter did in creating a game engine from scratch is provided in Unity.

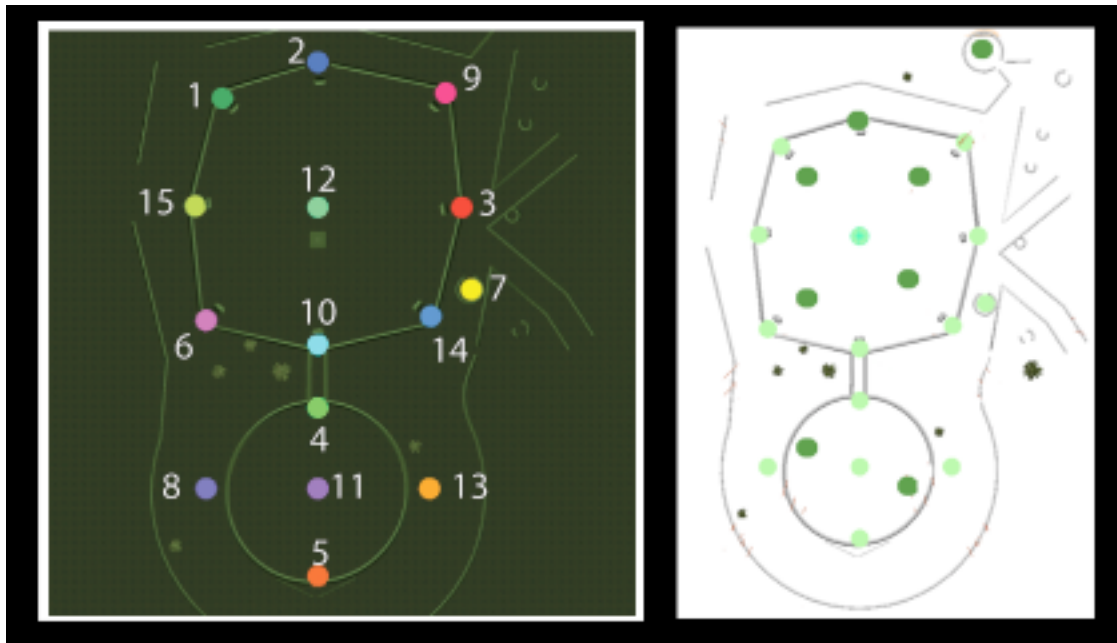


Figure 5. Hot spots in Maya. Tyler used numbers and colors in Maya to identify which group of images belonged in a particular place, left. On the right, the green dots represent the final configuration of hot spots.

Our intention had been to encourage the player to explore the space in order to grasp how large and awesome the space is, and so we conceived of a system to gather “markers” that

would allow one to “unlock” the moon and set it motion. That would set up the game of “catching the moon” on the rise. Tyler made several iterations of the marker (see Figure 7). A treaty from the 1800s inspired his sketches of animals. The Native Americans who signed it used drawn pictures to symbolize their ascent. The image on the left in Figure 7 replicates these signatures. For the final iteration of the markers, Michelle, using pictures of flint she shot at Flint ridge, used Photoshop to remove them from the background and gave them to Tyler. Then Tyler, also using Photoshop, came up with a way to create an embossed look, combining his drawings with the flint images (Figures 7 & 8).

The compass-like disc was intended to provide the primary interface for the player. The interface helps the player to understand the rules and provides player feedback. The dots or small circles represent how many moons one had caught and its position when caught. They fill in as the moon moves through the monthly cycle. Figure 6, above represents our final iteration. Unfortunately, we did not progress far enough in the development to allow us to playtest with very many people. We did get feedback from one of our core playtesters who said, “I don’t like it and I don’t not like it.” He thought it was “neat” and it was “earthy and natural looking.” Further data gathered from users at the Games + Learning + Society (GLS) conference provided valuable user feedback, but by June there were many features we had hoped to include that we could not implement (See Appendix B for GLS user feedback). Playtesting was to have occurred in the spring of 2012 and perhaps in the summer, but technical issues and a late start due to not understanding how the moon moves (see below) precluded our implementing the iterative design process. We did, however, create an online survey (on our website) and our current IRB builds upon the research we expected to do under this grant.

The most difficult task was in understanding how the moon moves. It took the Design Team a few months to figure it out. Dr. Michael Mickelson, professor of astronomy, invited us to the planetarium at Denison University and explained it to us, complete with handouts and multiple references. In addition, Bill Schmitt explained it to us. We looked online at multiple simulations and still it eluded us. Tyler tried to animate the movement in Maya so we could watch it. But, the way we finally figured it out was when Peter began making drawings of how the moon moved relative to the earthworks (see Figures 9 & 10). Until, he had figured this out, he was unable to program the moon’s movement within the game environment. This is a concept that is taught in elementary school through college and is very difficult to explain. The concept, as we now understand it, is that the moon moves in a monthly cycle which expands every month over 9.3 years and then contracts over 9.3 years, which comprises the 18.6 year cycle that is tracked by the earthworks.

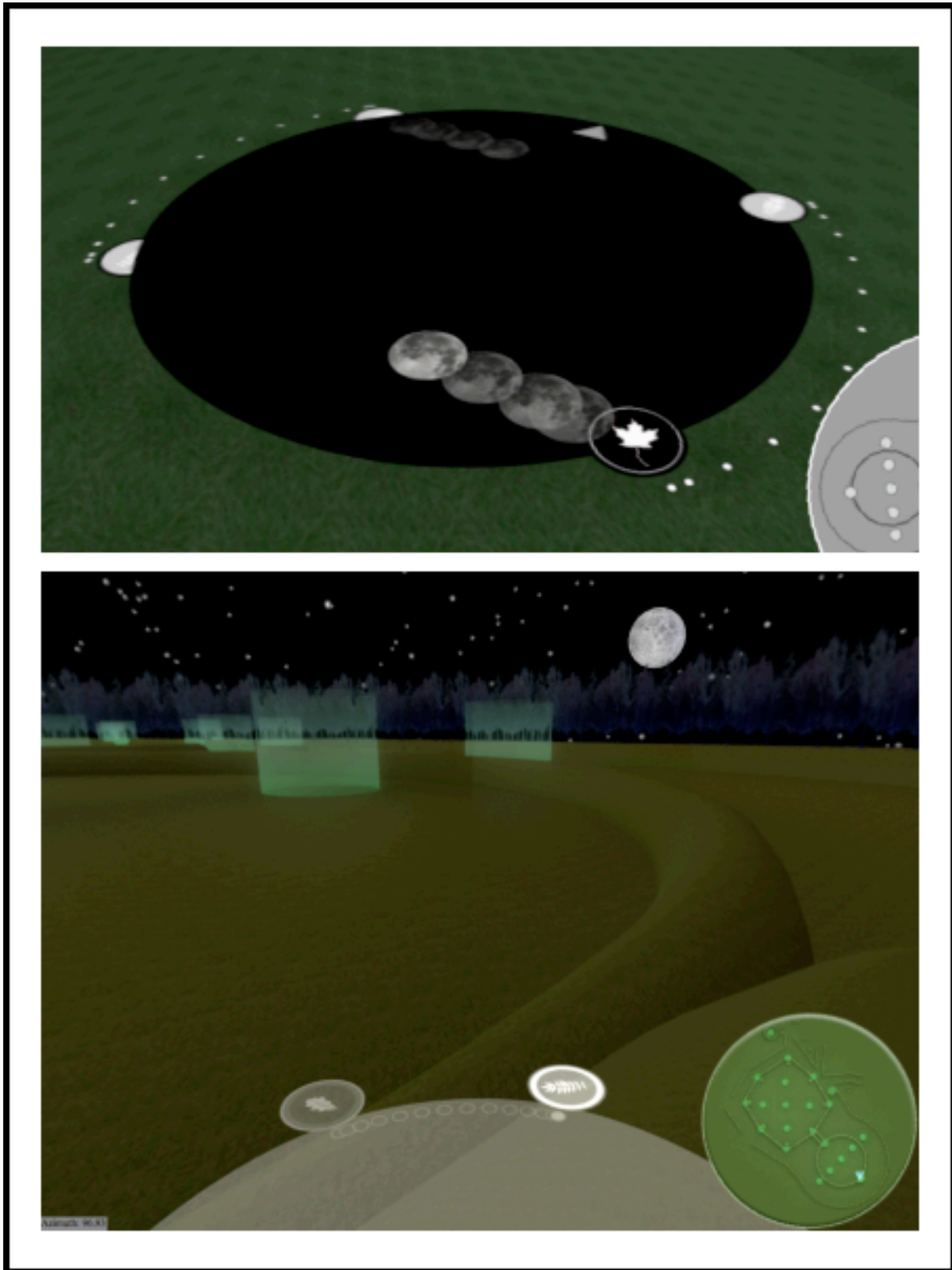


Figure 6. Above, compass interface to help the player know what was happening. Below, is the final iteration of the compass. Hot spots in the game were represented by a green glow.

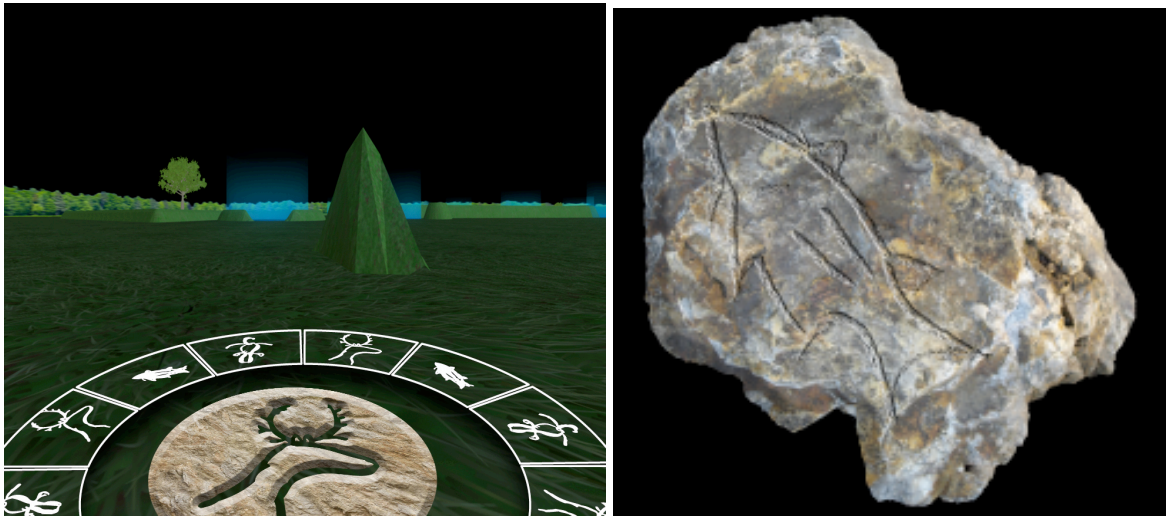


Figure 7. Markers: Left, one of Tyler's first iterations; right, final marker with embossed drawings.

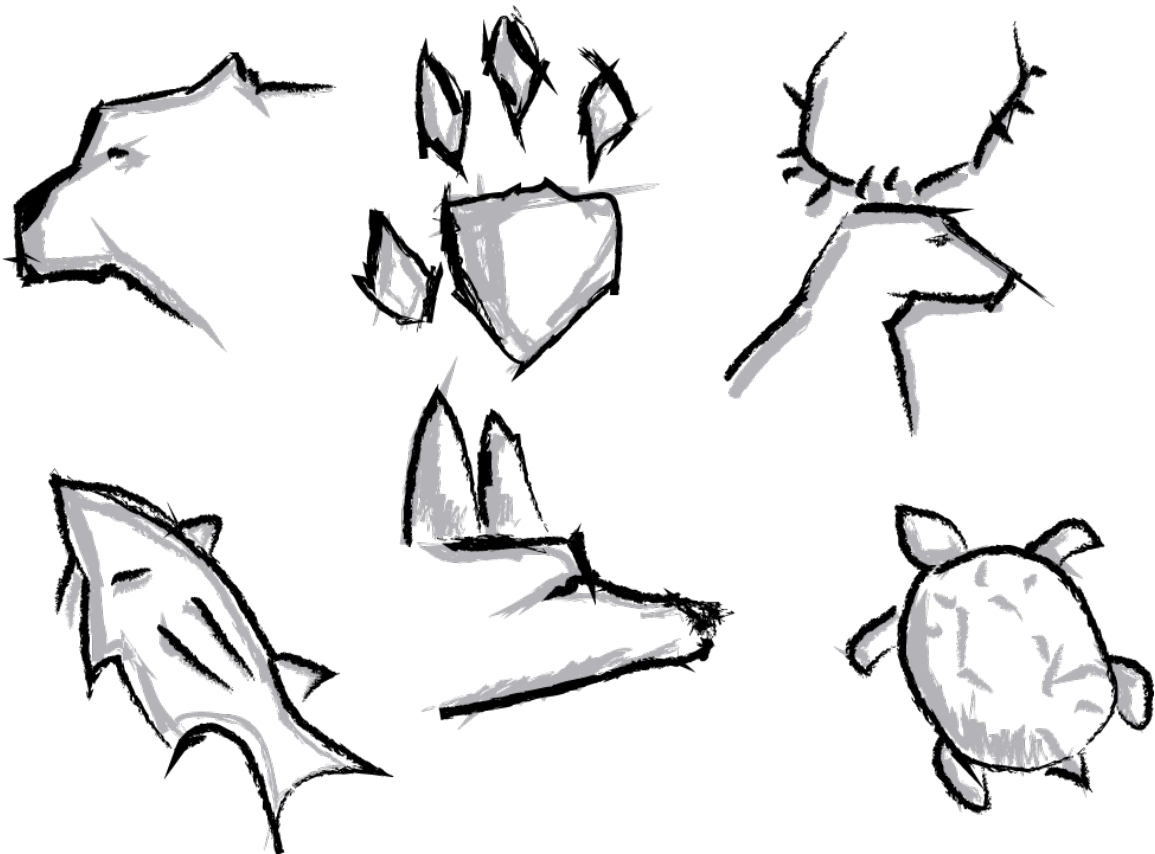
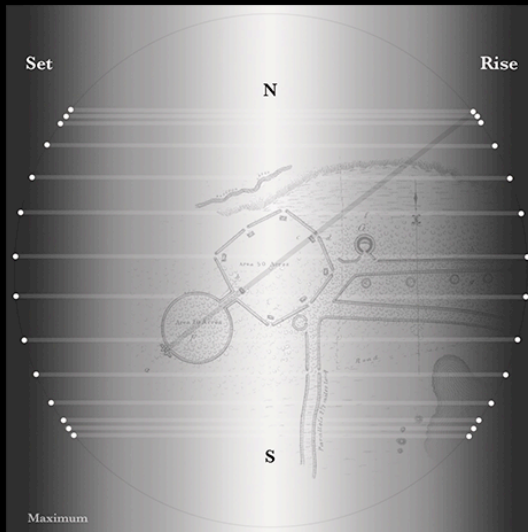


Figure 8. Tyler's animal drawings for the markers.

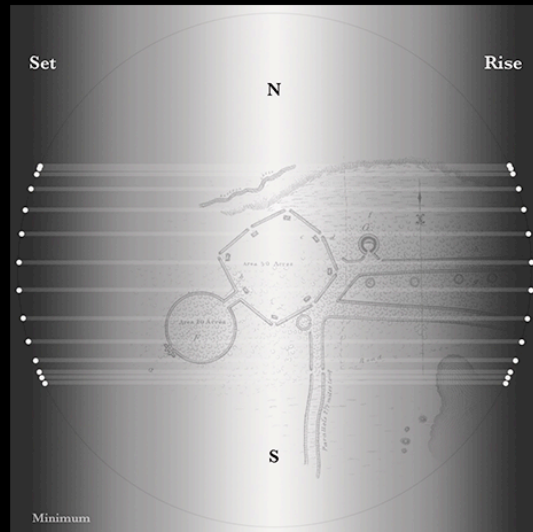
18.6 Year cycle of moon rise and sets at the Newark Earthworks, Ohio

Monthly Moon Cycle, year 1



Maximum rise and set

Monthly Moon Cycle, year 9.3



Minimum rise and set

Figure 9. Peter's yearly cycle at maximum and minimum rise and set points.



Figure 10. Peter has overlaid the rise and set points for the northernmost moonrise and set on a map of the Newark Earthworks – notice the golf course?

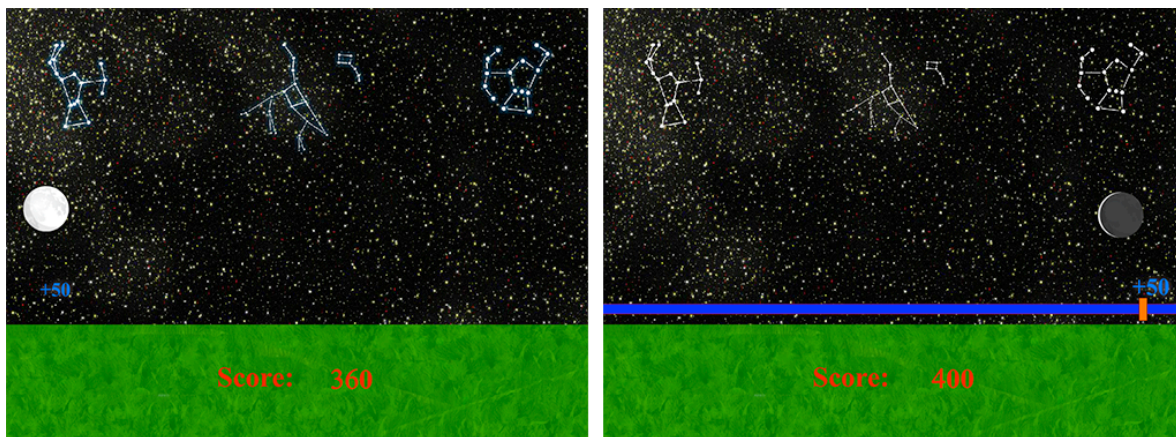
There are two iterations of the game on the website (<http://earthworksbuilder.github.com/>) that may be of interest: vo.9.0 and vo.10.0. Vo.9.0 is the last iteration from Peter. Vo.10.0 is one with some adjustments. Both should play in Flash Player 11. Several changes were made in order to repurpose the game into an experience of the environment and the movement of the moon. The necessity of finding the markers was removed; now the viewer clicks on the moon and the cycle runs. We also removed the directions and slowed down the movement of the stars; in vo.9.0 the stars are moving at a rate that accurately corresponds to the moon's movement. However, it moves so fast, it is dizzying. Vo.9.0 is still missing several elements that would constitute a game such as a point counter. In addition, there are several artifacting issues, in part due to the fact that the images are inside a box, instead of sphere.

In retrospect, it would have been better to be less accurate and have used a non-mathematical model, ignoring the azimuth and the longitudinal information. There is another project at Ohio State University that is working on making a simulation of this

phenomenon. Our project was to make a game, not a simulation that precisely mimics reality. Seeking accuracy became a red herring and took from January through March. This slowed the production greatly, resulting in a situation where we never had a play-testable product.

2D mini-game

After the project was nearly over, we asked for an extension and asked two students from the Digital Union at Ohio State to help by constructing an alternative prototype building upon everything the Design team had learned. Also using Flash, Larissa Borcz, developer, and Jon Diehl, Flash designer created a 2D mini-game (see Figure 11). Jon constructed a Flash file that depicts the moon's three cycles: daily, monthly, and yearly (<http://www.youtube.com/watch?v=6HQ4Ru-4b7c&feature=youtu.be>). Michelle asked Bill Schmitt to give us an approximation of how the moon moves during a monthly cycle. He provided the diagram below showing the position for the monthly cycle for the Northern-most and Southern most yearly cycles (Figure 12). Larisa also added in the phases of the moon. This prototype features two ways to “catch the moon” during a monthly cycle. The first mini-game, the player must click on the moon as it rises. The closer the click to the horizon, the more points one may earn. The second provides a slider that the player moves to predict where the next rise. In addition to points, the player also receives a constellation. In future iterations, we expect to tie in storytelling and constellations more clearly. One suggestion was to encourage the player to pick a particular constellation before playing the game as a way of identifying with a particular tribe. As the player progresses, this constellation would build. Once it is complete, the player will receive a story. This could be a way of building player identity within the game.



Catch the Moon on the rise!

Slide the bar to predict where the moon will rise.

Figure 11. Screen shots of the 2D mini-games. Notice the phases of the moon – it changes as it moves from left to right.

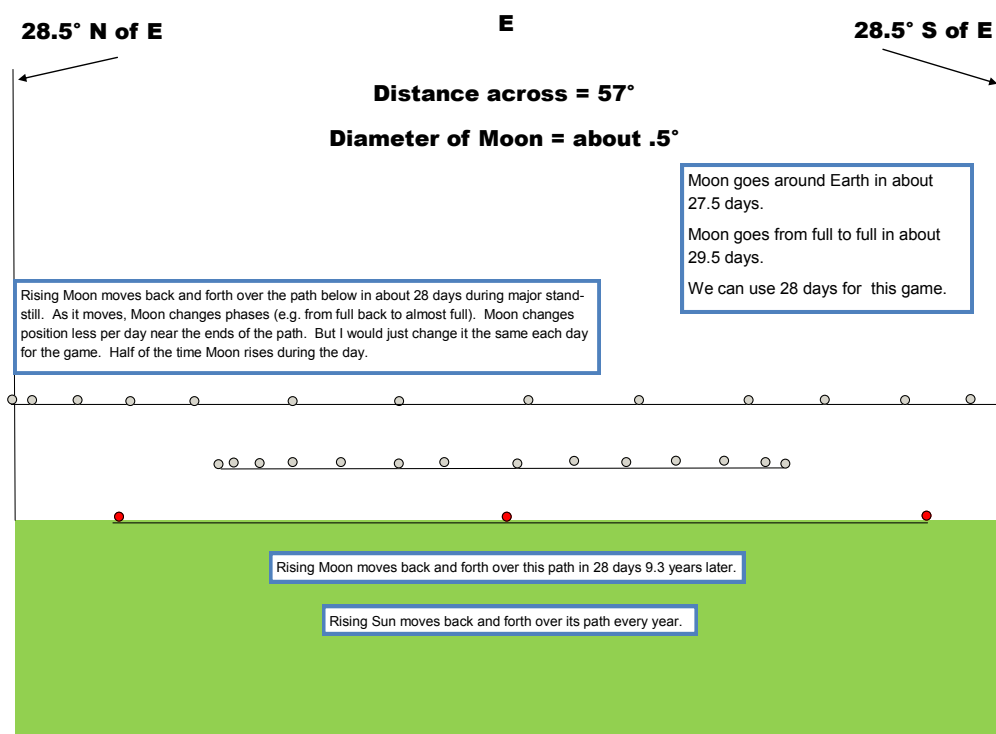


Figure 12. Bill Schmitt's diagram of how the moon moves in a monthly cycle. The top row is the widest movement, corresponding to the northernmost lunar standstill.

Bill Schmitt, science educator, was so impressed with the mini games, that Michelle will be submitting poster session proposals to two international physics teaching conferences this summer (2013) to demonstrate the project and the 2D game: the InterAmerican Conference on Physics Education in Ecuador and the Groupe International de Recherche sur l'Enseignement de la Physique [GIREP] Conference in Prague, and the National American Association of Physics Teachers meeting in Portland, OR. While she would not normally attend such conferences professionally, her husband is a professor who does physics education research; she plans to accompany him to these conferences. This project has crossovers into physics teaching so will likely be accepted for a poster and game demo.

Constellation Research and Sound Assets

Michelle worked on identifying constellations and constellation stories. She compiled a list of books that provided accurate information and Christine selected the stories we were to focus upon. Michelle and Bill Schmitt used an accurate star map that Peter found. She put it onto a sphere in Maya and then identified a list of Greek constellations that corresponded with the stories selected by Christine. She made small images that could be mapped onto the star map in the game space and “appear” as rewards. This aspect of the game was never implemented, nor was a point counting system. She also made sound effects that largely were not employed due to time constraints.

Several sound effects were made using Native American instruments: a drum, shaker, and antler rattle. The Digital Union at OSU provide the use of the “Whisper Room,” a sound proof room with recording equipment. Jon Diehl was given permission to use Christine’s instruments to record sounds that sounded like thunks, clunks, and clicking. Additionally, the Native American Advisory team was meeting and they agreed to play instruments and sing, resulting in more options. In addition, several open source sound effects were gathered and prepared for looping, such as crickets, birds, wind, and water. A friend of Dr. Ballengee-Morris’, Terry Asbury, composed and recorded original flute music for the game called *A Journey*.

Conclusion

We attended several conferences (See Appendix C) and expect the project to continue to grow. Given audience enthusiasm and interest we anticipate that there will be a growing user audience. Nearly all of the people who started with this project are continuing. As stated above, we have added more content specialists and Native American Advisory Team members. In the appendices for the Final Report we include: a link to the poster presented at Innovate 2012 (in Appendix C: <http://meet-the-earthworks-builders.posterous.com/>), the GLS demo user feedback, a list of conference presentations and publications, and NA Team list of important topics to include from the Fall 2011 meeting.

Overall, the project is growing. The seeding of our idea for a game from the NEH benefited us in several ways:

- It was the impetus for forming the Native American Advisory Team;
- It allowed us to develop game ideas and begin creating them, resulting in a 2D prototype;
- It forced art-minded people to understand how the moon moves and represent it visually and in ways vastly different from other ways of explaining it. When we discussed it with one physics instructor at OSU, she said it blew her mind and she would have to rethink how she teaches it;
- It gave us credibility in seeking additional funding;
- It served to lay a foundation for the consulting collaborative approach that will be used in all subsequent grants.
- It provided the basis for applying for a grant to implement James Gee’s (2012) concept of the “Big G;”
- With it, the work we’ve done has led to other professionals to join us who will be instrumental in creating a quality educational game. With NSF funding (pending) we will be able to work with Dr. Nancy Maryboy, Native American Astronomer and President and Executive Director, Indigenous Education Institute, Dr. Megan Bang, Native American and Assistant Professor, Educational Psychology at the University of Washington, who led us to Dr. Allen Turner, Assistant Professor, School of Cinema and Interactive Media at DePaul University, and professional game designer; Jesse Schell Game Company to develop the game; and especially Reed Stevens, Professor in Learning Sciences at Northwestern with whom we will implement his method for qualitative research about game play;

- Most importantly, it helped us to go deeper in our thoughts and reflect about what is needed and whom we need to work with, and as is evidenced above, we have found those people.

We consider this project to have been a success and we are very excited to see how it will grow. We hope it will transform the way people view modern Native Americans, move the field of educational games forward, and spur research by Indigenous people about the earthworks and ancient artifacts – perhaps, building upon an idea from Marti Chaatsmith, Native American Advisory Team, connecting found ancient artifacts with art made by various tribes today. We expect that we will continue to obtain funding to further develop the Earthworks Badges website and finish the game. Most importantly, we hope it will provide a voice for Native American Nations that honors the diversity and differences among them.

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Appendices

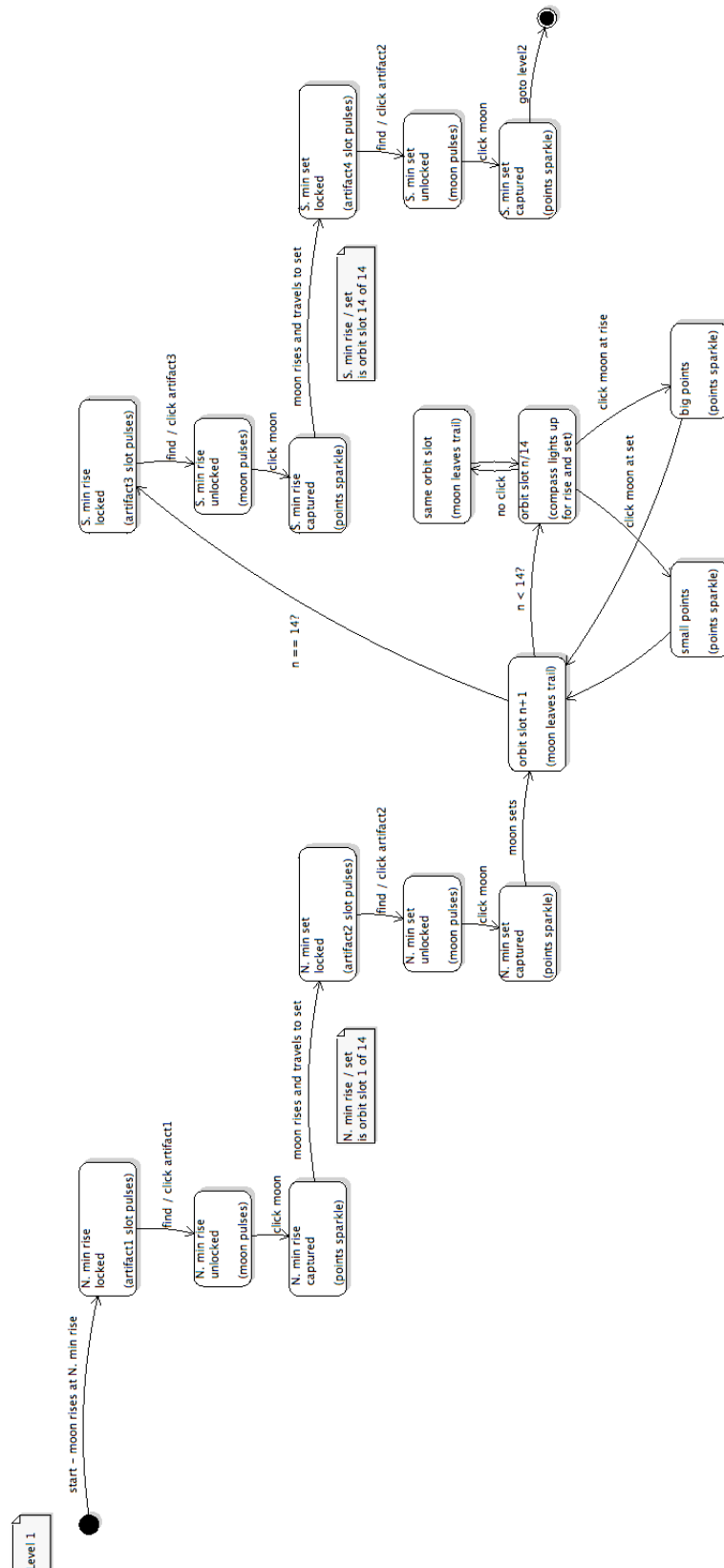
Appendix A – Game play diagram

Appendix B – Informal feedback from the Games + Learning + Society Conference
Feedback from playtester, May 2012

Appendix C – Conferences: Presentations, Posters, and Demonstrations.
Papers and Proceedings

Appendix D – Native American Advisory Team Notes, Fall Meeting 2012

Appendix A
Game States
Level 1
Diagram by
P. Gerstmann



Appendix B

Feedback from the Games + Learning + Society Conference
Shared with the Game Design Team in June 2012

Educational Game Arcade

Published Proceedings

Aubrecht, M., Ayres, T., Gerstmann, P., & Norton, D. (2012) In C. Martin, A. Ochsner, & K. Squire (Eds.) Meet the Earthworks Builders Video Game. Proceedings from *GLS 8.0, Games + Learning + Society Conference* (p. 497-8). Pittsburgh, PA, ETC Press.

Our paper is available here:

<http://www.etc.cmu.edu/etcpres/content/gameslearningsociety-conference-proceedings>

Informal user feedback

Navigating the space

1. 360 movement is disorienting when one looks up.
Fix: Camera axis change
2. User doesn't see the correlation between the top down map and the environment
Possible Fixes:
 - Have the dot on the mini map grow slightly and a corresponding brighter glow of the hot spot
 - Create a transition from the title and instructions to the game. This would be a wide shot of the Newark Earthworks as a whole, zoom in to the section in game, cross fade to game, maybe focus on mini map and pull camera back to see the space, during which the compass is revealed. Camera pans up and the hot spots fade up with corresponding glow on the mini map. In addition, there could be a quick flash of the arrow keys, player moves camera. The problem with knowing where to click may be solved with pulses as we've discussed. (see problem below)
3. Movement
 - a. People (everyone) want to use the mouse to move – they never try the arrows first
 - b. They also try to click on the map but is so small they don't always get it right the first time,
 - c. No one clicks on the larger hot spots
4. Need more visual change to let people know they've moved.
Possible Fixes:

- Show a line that retracts – the line connects where you were to where you are (mini map)
- Hover over a spot on the mini map – dot grows slightly (indicates you can click on it)

What it's about/ where are they?

5. People think they are on a planet somewhere off world. The lights make it look otherworldly.
6. The overall goal is unclear
Possible Fix: state the goal in an intro

What does the player do?

7. Markers position is confusing because they are floating and so large
8. User lacks feedback regarding finding markers
9. People aren't finding the compass because it is off screen when the game opens

Michelle's thoughts –

It looks like the compass is set up to indicate the Max positions instead of the Min ones.

How the compass works:

The little dots indicate where the moon is in the cycle, but in the first level the max positions shouldn't be visible. Just the min n. most and min s. most. Then as the moon moves in the monthly cycle 12 more little dots will show up as the player clicks the moon (catching it) and moving it through the cycle. When it hits the last spot, it cycles back by itself. If the player catches the moon, she gets more points, but is no longer controlling the progression/cycle

User Feedback – May 2012

1. thought it was "neat. The game will probably be interesting. Because it's an interesting space."
2. "earthy and natural looking"
3. at first he didn't know what to do, suggests brief instruction such as how to navigate the space - for example if something was glowing/flashing he might have clicked on it.
4. didn't know to use the arrow keys. I did suggest it and also clicking on a mound/glowey thing. tried w,s,d, a and mousing around, and arrow keys.
5. regarding the top down map, "I don't like it and I don't not like it."

Appendix C

Conferences: Presentations, Posters, and Demonstrations.

Ballengee-Morris, C. (2013, Mar.), *Digital World and Native Arts*, presentation. National Art Education Association Convention, Fort Worth, Texas.

Ballengee-Morris, C. & Aubrecht, M. (2013, Feb.), *Meet the Earthwork Builders*, presentation. eTech Ohio, Columbus, OH.

Ballengee-Morris, C. (2013, January), *Earthworks Around the World*, Keynote Talk at The Ohio State University, Newark Earthwork Center, Newark, OH.

Ballengee –Morris, C. (2012, November). *Contemporary Indigenous Issues and Solutions*. World Alliance of Arts Educators Conference. Lapland, Finland.

Ballengee-Morris, C. & Aubrecht, M. (2012, Oct.), Booth demonstrations for 3 days. National Indian Education Association Conference, Oklahoma City, Oklahoma.

Ballengee-Morris, C. (2012, June), *Earthworks and Education*, presentation. Native American and Indigenous Studies Association Conference, New York, NY.

Aubrecht, M. (2012, June), *Meet the Earthworks Builders*, Educational Games Arcade, demonstration. Games + Learning + Society Conference, Madison, WI.

Ballengee-Morris, C. & Aubrecht, M. (2012, March). *A Video Game Connecting The Earth, The Moon And The Past...* Poster and Demonstration. Innovate! Transformation. Ohio State University, Columbus, Ohio.
Can be downloaded from: <http://meet-the-earthworks-builders.posterous.com/>

Ballengee-Morris, C., Willis, S., Delacruz, E. (2012, Feb.), Contemporary American Indian Arts, presentation. National Art Education Association Convention, NYC, New York.

Papers:

Aubrecht, M. & Ballengee-Morris, C. (in press). Game Changing: Developing Meet the Earthworks Builders. In *Psychology of Gaming*. Editor, Y. Baek. Nova Science Publishers, Inc. Hauppauge, NY.

Proceedings:

Aubrecht, M., Ayres, T., Gerstmann, P., & Norton, D. (2012) In C. Martin, A. Ochsner, & K. Squire (Eds.) *Meet the Earthworks Builders Video Game*. Proceedings from *GLS 8.0, Games + Learning + Society Conference* (p. 497-8). Pittsburgh, PA, ETC Press.

Appendix D

Native American Advisory Team Notes

Presented by Marti Chaatsmith

October 2012

The player will understand that the earthworks were:

Built by Indians of the Woodlands culture

Built 2000 years ago

The woodlands culture had been developing over thousands of years (perhaps 10-20,000 years ago)

The woodlands culture was sophisticated and complex

“specular EWs – what is correct

most important topics:

- theories about how EW built
- theories about cultures that built them
- standard & measure & shapes
- astronomical observatory
- AI history elements:
 - #'s and cultures here up to 1491
 - pandemics, agriculture, cultural destruction upon settlement
 - group tribes in OH 1491-1600
 - removal
 - return